

FETC Background in Reciprocating Engine Program and Project Management¹

The former Morgantown Energy Technology Center (METC) now the Federal Energy Technology Center (FETC) initiated a coal-water slurry (CWS) fueled heat engine program in 1982 in response to rapidly increasing oil prices due to an Arab Oil Embargo and the perceived threat to future oil availability. These initial efforts in 1982 and 1983 were devoted to examining the feasibility of the use of CWS and coal powders in diesel engines. Their results were promising and a major procurement announcement was released in 1984. At this point, FETC established an in-house engine R&D facility to support development of CWS and coal-derived liquid fuel engine applications. The facility includes a high-speed single cylinder research engine and constant volume combustion apparatus for alternative fuel development. The facility also has capability for in-cylinder combustion analysis, diesel particulate analysis and full emissions analysis in accordance with EPA guidelines, CFR 40, Part 86, Subpart N.

Three large feasibility studies were awarded in early 1985 to three major medium-speed engine manufacturers. The goal of the feasibility studies was to identify the technical barriers impeding the development of the CWS engine systems. The focus of the joint A.D. Little and Cooper Bessemer project was the development of a stationary cogeneration engine system. This project eventually led to the current clean-Coal Demonstration/commercial installation of a CWS fueled diesel engine at the University of Alaska Fairbanks (UAF). The engine generator set is due to begin commissioning in next month (July 1999). The UAF has an excellent website dedicated to this project at (www.uaf.edu/pps/cleancoal/home.htm). The General Electric and General Motors projects were both focused on the development of railroad locomotive systems. All of the studies included economic assessments of potential utilization of the existing technology in the respective applications. Over the course of the projects new technologies were developed and economic assessments were continually re-evaluated in terms of the new information. The results of the GE and the A.D. Little feasibility studies both indicated that relatively inexpensive coals were feasible. General Motors, on the other hand, concluded that the Electro-Motive engines would require the more expensive ultraclean coals. In parallel, FETC management of these projects was supported by in-house system modeling expertise in fuels and system analysis. System studies done by FETC in-house economists and engineers lead to new approaches often implemented by the CWS engine developers.

A major procurement was issued in 1988 to fund the follow on work of both the GE and the A.D. Little projects. Work was halted on the GM project because of Electromotive's insistence on continuing the development efforts using only ultra-clean coals, an approach that the economic studies indicated was not viable.

The A.D. Little/Cooper technology development project remained focused on the continued development and demonstration of technologies examined on the feasibility

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study. The goal was to demonstrate these technologies on a multicylinder engine at the Cooper research facility in Mount Vernon, OH. This goal was achieved in 1993.

The GE Technology Development Project also included continued development of the technologies introduced in the feasibility studies. The goal of this project was to demonstrate these technologies in a multicylinder GE engine operated on the test track at the GE facility in Erie, PA. This goal was achieved in 1992.

Selection of the medium-speed engines as the focus of the program was based on early modeling work done by Caton and Rosegay at Texas A&M, which indicated that the maximum engine speed for burn-out of coal particles in the 10 micron size range was 1000 rpm. While these model results were in agreement with later modeling work by FETC and others, some preliminary experiments reported by Kakwani at Adiabatics, Inc., indicated that much higher speeds were possible. These results were verified in a project with Detroit Diesel Corporation and Southwest Research Institute initiated in 1991, and performed in a 1900 rpm Detroit Diesel 8V-149 engine used in mine haul truck applications. Thus, CWS technical feasibility was extended to high-speed engine applications. The CWS engine program was terminated in 1993 after clearly demonstrating the technical feasibility of operating CWS fueled reciprocating engines. Continued cheap and plentiful oil has impeded the full commercialization of these systems. However, FETC's response to the nationwide oil crisis of the early 1980's was to provide exactly what railroad companies and stationary engine manufactures asked for.

FETC continues to maintain management and technical expertise in the reciprocating engine area as well as other heat engine and fuel areas. The FETC website allows viewing of the program documents for all of their product areas. Particularly pertinent are the programs for Advanced Heat Engines, Natural Gas Supply and Storage, Natural Gas Processing and Transportation Fuels and Chemicals. Again, a related list of reciprocating engine publications is attached.

Recent activities in the stationary natural gas engine area has led to development of the Advanced Reciprocating Engine System (ARES) Consortium. This consortium is headed by DOE and is centered at Southwest Research Institute (SWRI) in San Antonio, Texas. The consortium consists of four (4) engine manufactures and several engine component suppliers. The consortium was formed in October 1998 to perform pre-solicitation research activities to identify R&D areas that would best leverage future efforts to achieve the aggressive ARES Program goals. Further, aggressive university participation in an January 1999 ARES workshop identified several potential future academic partnerships. The workshop, as well as the development of the consortium, was primarily the result of the efforts of SWRI and DOE. Currently, FETC and EE are maintaining close ties with the ARES consortium and SWRI in developing the baseline for the ARES engine program. FETC is currently supporting the consortium engine R&D efforts via in-house engine testing at FETC in support of knock model development at SWRI and via planning for future ignition systems development at FETC.